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Phycological studies — III. Further notes on Halimeda and Avrainvillea

MARSHALL AVERY HOWE

(WITH PLATES 25–30)

A. On the sporangia of Halimeda tridens and of Halimeda Tuna

The sporangia of the genus *Halimeda* were for many years known only in the single species *Halimeda Tuna*,* though in 1876 Zanardini † briefly described those of *H. macroloba* and in 1880 Schmitz ‡ contrasted the characters of the sporangiophores of *Halimeda Tuna* with those of *H. platydisca*. But the true *Halimeda platydisca* Decaisne, according to the original preserved in the Muséum d'Histoire Naturelle of Paris, appears to be simply a large form of *H. Tuna*,§ and whether Schmitz was really dealing with two distinct species or with two forms of *H. Tuna* is not altogether clear. In 1904, Mrs. Gepp ‖ described and illustrated in detail the sporangia and sporangiophores of *Halimeda gracilis*

* Derbès & Solier, Suppl. Compt. Rend. 1: 46, 47. *pl. 11. f. 18–22. pl. 12. f. 1–5.* 1856.

Bompard, Hedwigia 6: 129. 1867.

Zanardini, Mem. R. Ist. Ven. 19: 541–543. *pl. 30.* 1876.

† Zanardini, *l. c.* 543.

‡ Sitzungsber. d. niederrheinischer Ges. f. Natur- und Heilkunde 1880: 140–146. 1880.

§ Barton, E. S. The genus *Halimeda*. Siboga-Expeditie, Monographe 60: 14. 1901. The present writer, after examining the same type, concurs with the monographer of "The genus Halimeda" in the opinion that *H. platydisca* does not offer any satisfactory characters in form or structure to distinguish it from *H. Tuna*.

‖ Gepp, E. S. The sporangia of *Halimeda*. Jour. Bot. 42: 193–197. *pl. 461.* 1904.

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and *H. Tuna*, using for her studies of the latter, through the courtesy of M. Ed. Bornet, "a portion of the identical specimen" described by Derbès & Solier. Mrs. Gepp in this paper brought out some especially interesting facts in regard to the relation of the sporangiophores to the filaments of the central strand.

In 1905, in distinguishing the newly recognized species *Halimeda scabra*, an ally of *H. Tuna* from Florida and the Bahamas, the present writer * described and figured its sporangia and alluded to a fertile specimen of *H. Tuna* collected in Bermuda. In view of the rarity of the occurrence of fertile specimens in this genus, it may be remarked that the Bermuda specimen was found in the month of June and the Florida specimen of *H. scabra* on March 30.

In each of these cases only a single plant out of the many observed was fertile. But on March 3, 1906, near the mouth of the main harbor of Culebra Island, Porto Rico, the writer found, growing near the low-water mark, an abundance of *Halimeda Tuna* laden with sporangia. The photograph published herewith (PL. 27, FIGS. 2–4) gives an idea of the appearance of these fertile specimens and of the position of the sporangia upon them. The sporangia occur chiefly in crowded clusters on the margins of the segments, but they are also often scattered over the discs or flattened faces of the segments, which they occasionally cover almost completely. Derbès & Solier and Mrs. Gepp describe and figure the sporangia of *Halimeda Tuna* as occurring only on the margins of the segments, but Zanardini both describes and illustrates them as occurring also on the discs. The sporangiophores are 1–2 mm. long and both in these Porto Rican and in the Bermudian specimens they are apparently rather more simple (PL. 25, FIGS. 7–9; PL. 28, FIGS. 1 and 2) than those of the European *H. Tuna;* at least, we have never observed the forking which Mrs. Gepp has described and figured (*l. c., f. 6*) as occurring immediately after the fusion of their basal filaments. All the sporangiophores that we have seen are either simple or once dichotomous near the top — somewhat resembling Derbès & Solier's *figure 2*. Those springing from the margins of the segments (PL. 25, FIGS. 8, 9, 10) are formed by the fusion of two or three filaments of the central strand, but those springing from the discs or flattened faces come directly

* Bull. Torrey Club 32: 241–244. *pl. 11, 12.* 1905.

from the medullary filaments, in most cases, at least, without any fusion, and often apparently lateral in origin (PL. 28, FIGS. 1 and 2). This latter condition is at variance with Mrs. Gepp's conclusion (*l. c.*, p. 196) that in both the vegetative and reproductive parts of *Halimeda* "all fresh growth is preceded by a fusion of filaments of the central strand," but in the specimen examined by Mrs. Gepp the sporangiophores apparently arose only from the segment-margin, in which case in the American plants also fusion is the rule and perhaps universal. The sporangia of these Porto Rican specimens vary from pyriform-obovoid to subglobose and are 0.20–0.33 mm. broad; in arrangement they are somewhat botryoid or irregularly distichous. The plants were kept for a time in a jar of sea-water with the hope that the living zoospores might be seen, but the experiment was unsuccessful, probably on account of lack of continuous observation.

On March 22, 1906, the writer was so fortunate as to find near Tallaboa on the southern shore of Porto Rico, growing in about one meter of water (low tide), two fertile specimens of *Halimeda tridens*,* a species which seems to have been known previously only in a sterile condition, though it was originally described as long ago as 1786 and has since been often collected. A photographic representation of one of these plants is given on PLATE 27, FIG. 1. In comparing it with the fertile specimens of *H. Tuna*, one is impressed at first by the very different color of the sporangia, which are uniformly yellowish-brown or of a burnt-umber shade, while those of *H. Tuna* are uniformly of a bright, dark, intense green. The sporangiophores are the most densely clustered along the upper margins of the segments, especially at the apices of the lobes when lobes are present, but they may emerge from any part of the segment and sometimes completely cover its surface. The second plant, the one not shown in the photograph, is the more densely laden with sporangia, and some of its branches are so thoroughly covered as to obscure their segmentation. The sporangiophores are a little longer than those of *H. Tuna*, ranging from 1.3 to 2.3 mm. in length, and they are much more branched, being 1–5 times dichotomous. We have not seen one wholly simple. The sporangiophores that spring

* For remarks on the name of this species, see page 501.

from the margins of the segments (PL. 28, FIG. 3) are mutually coherent near the point of emergence and communicate with each other there by pits or pores like the vegetative filaments of the central strand at the nodes, but the sporangiophores from the disc-surfaces originate as direct continuations of the peripheral utricles or of the utricles of the subcortical layer and are without fusions or adhesions of any kind (PL. 28, FIGS. 4–7). The sporangia are obovoid or pyriform and are 0.20–0.38 mm. broad. The callose or mucous plugs which we have described * as forming basal septa of a certain sort for the sporangia of *Halimeda scabra* we have not observed in *Halimeda tridens;* such are, however, of occasional and irregular occurrence in the Porto Rican material of *Halimeda Tuna.*

B. ON THE AMERICAN SPECIES OF THE HALIMEDA TUNA GROUP

At the time of describing the strongly marked species *Halimeda scabra,*† attention was directed to another species which likewise had commonly been confused with *Halimeda Tuna.* Of this "smooth plant of the *Tuna-cuneata* alliance," we remarked, "It seems rather violent to identify it either with *Halimeda Tuna* or with *H. cuneata,* and it is possible that further acquaintance with it will show constant and reliable characters for distinguishing it from both." At that time nearly all of our American material of the *Tuna* group belonged to this "species inquirenda" and to *H. scabra* and the only specimens we had seen from the American side of the Atlantic which we could refer to *H. Tuna* were from Bermuda. But since then we have collected what we believe to be the true *H. Tuna* both in Porto Rico and in Jamaica and have seen a specimen of it purporting to come from Key West, Florida, so it now seems probable that both it and its ally are of general distribution in the West Indian region. And the two "forms," so far as we have seen them, are always absolutely and abundantly distinct and in our opinion are as much entitled to be considered specifically different from each other as are *Halimeda Tuna* and *H. Opuntia* or *Halimeda Tuna* and *H. scabra.* It soon became evident that this ally of *H. Tuna* had already been recognized as

* Bull. Torrey Club 32: 243. 1905.

† M. A. Howe, Bull. Torrey Club 32: 241–244. *pl. 11, 12.* 1905.

a species, and it appears that the earliest available name for it that conforms with prevailing rules of nomenclature is *Halimeda discoidea* Decaisne,* under which name the species is described below:

HALIMEDA DISCOIDEA Decaisne, Ann. Sci. Nat. II. **18**: 102. 1842.

? *Halimeda papyracea* Zanard.† Flora **34**: 37. 1851; Mem. R. Ist. Ven. **7**: 288. *pl. 13. f. 2.* 1858.

Of a light bright-green color and lubricous when living, becoming yellowish- or albescent-green and more or less pergameneous or papyraceous and smooth to the touch on drying, suberect or decumbent, 5–15 cm. in height or length, subsessile, very lightly calcified, the calcification usually confined to the narrow area lying between the coherent ends of the peripheral utricles and the distal ends of the subcortical utricles, in the oldest parts sometimes involving the distal half of the subcortex; the branching in one plane, mostly frequent or somewhat congested, usually di- or trichotomous, the larger subbasal segments sometimes originating five or six branches: segments discoid, enervate, deltoid-obovate, semiorbicular, reniform, or subelliptical (with longer axis transverse), 6–35 mm. broad, mostly 0.3–1.2 mm. thick, those near base scarcely different, but sometimes attaining thickness of 1.75 mm., margins entire, the surfaces commonly nitent when dry or in younger parts dull and very minutely spongiose: peripheral utricles mostly hexagonal in surface view, 40–85 μ in diameter, often fusing in twos, threes, or rarely fours, and therefore appearing

* The name *Corallina discoidea* Esper (Pflanzenthiere, Fortsetz. 2, *Corallina, pl. 11.* 1798–1806) appears to have fallen short of effective publication according to both the Vienna and the Philadelphia codes of nomenclature, so may be ignored in determining the correct name of the present species, whether Esper had this species before him or not. The name first appeared on a plate, illustrating a large *Halimeda* of the *Tuna* group, without analysis of parts and without descriptive or explanatory text. In a continuation of Esper's work by F. L. Hammer, many years later (3: 356. 1830), the name (changed to "discoïdes") is found in the synonymy of *Halimeda Tuna*, with a reference to the plate. Esper's plant cannot be satisfactorily determined without examining the original, which, it would seem, is not now to be found in his collections preserved at Erlangen. Lamouroux is sometimes quoted as having a *Halimeda discoidea* but it would appear that he never actually published such a binomial. In 1812, in establishing the genus *Halimeda*, Lamouroux mentions among the examples *Corallina* "*discoidea* Esper," but we do not find that he ever actually printed or adopted the name *Halimeda discoidea*. In the same paper he mentions "*Corallina flabellum* Ell." as an example of his new genus *Udotea*, but when four years later he came really to enter the species into *Udotea* it became *Udotea flabellata* instead of *Udotea Flabellum*.

† See footnote on following page.

larger and of irregular outline, mostly subquadrate, subquadrate-oblong or cyathiform in lateral view, less commonly cornucopiae-form, 65–150 μ long (including the usually slender stalk), truncate at apex, in firm contact above with those adjacent for $\frac{1}{5}$–$\frac{2}{3}$ their length, often interlocked, separable with much difficulty on decalcification: utricles of the subcortical layer in a single series, bullate, varying from broadly funnelform to subglobose or ellipsoidal, mostly ventricose-obovoid, 110–215 μ in maximum width, always much larger than the peripheral utricles, 4–14 of which commonly arise from the subtruncate apex of each: filaments of the central strand fusing in twos or rarely in threes at the nodes, not coherent, the fusion often incomplete: sporangia unknown. [PLATE 25, FIGURES 11–20; PLATE 26.]

TYPE LOCALITY: Unknown ("Kamtschatka, Voyage de la Vénus," according to presumably erroneous label); type specimen in the herbarium of the Muséum d'Histoire Naturelle in Paris.

DISTRIBUTION: Southern Florida and the West Indies; Hawaii; Celebes; Red Sea; probably of general distribution in the tropical seas.

In giving the distribution of the species as above, we are guided only by specimens now in the herbarium of the New York Botanical Garden. Both *Halimeda discoidea* and *H. Tuna* occur in Oahu, Hawaiian Islands. We have specimens of *Halimeda Tuna* also from the Philippines, Singapore, and from some of the East Indian islands visited by the Siboga Expedition, and it seems probable that both *H. Tuna* and *H. discoidea* have a wide distribution in the tropical parts of the Indian and Pacific oceans, as well as of the Atlantic. Askenasy's *figure 11* (Forschungsreise S.M.S. Gazelle **4**: *pl. 4*) was very certainly drawn from a specimen of *H. discoidea*, apparently from Dirk Hartog Island, Western Australia, though it was identified by Askenasy with the quite different *H. macroloba* Decaisne. The specimen of *H. discoidea* from the Red Sea, which we have cited above, was collected by Boissier in 1855 (*no. 5*) and was distributed as *H. macroloba*. This specimen resembles very closely Zanardini's figure of his *Halimeda papyracea*, the type * of which also came from the Red Sea. The specimen from the Celebes which we have cited was

* We have been unable to locate the type specimen of Zanardini's *Halimeda papyracea*, which does not appear to exist in his herbarium now preserved in Venice. Mrs. Gepp, in her monograph of the genus *Halimeda* (p. 15), mentions that she had been allowed to see this type specimen "through the kindness of Dr. Beccari." Dr.

distributed as *Halimeda Lessonii* Bory, but we have no conclusive proof that it is an authentic representative of what Bory intended to have bear this name. Moreover, this alleged name of Bory's, so far as the literature of the subject is concerned, appears to be merely a "nomen nudum" without even an indication of the source of the specimen beyond what one may infer from the name itself, and it therefore deserves no recognition in synonymy.

Halimeda discoidea has of late been confused chiefly with *H. Tuna* forma *platydisca* (Decaisne) Barton. The original specimen of *H. platydisca* Decaisne (in herb. Mus. Paris.), as already determined by Mrs. Gepp, seems to be simply a very large condition of *Halimeda Tuna*. Its peripheral utricles show occasional fusion, but they have the form and light contact of *H. Tuna* and the utricles of the subcortical layer also are those of *H. Tuna* and the plants have the heavier calcification of that species. The segments of *Halimeda discoidea* are usually but not always larger and more inclined to be obovate than those of *H. Tuna* and by these characters, together with the lighter calcification of *H. discoidea*, the two species can usually be distinguished at sight, but reliable diagnostic characters can always be found in the amount of contact of the peripheral utricles and in the form and size of the utricles of the subcortical layer. The more important histological characters of the two species are contrasted below:

	Halimeda Tuna	*H. discoidea*
Calcification.	Moderate. Involving subcortical layer, often also the medulla and the bases of the peripheral utricles but rarely extending to the surface.	Slight. Usually confined to the distal ends of the utricles of the subcortical layer.
Peripheral utricles.	Rounded-truncate, 30–70μ in diameter, very rarely fused, in contact above with those adjacent for $\frac{1}{20}$–$\frac{1}{8}$ their length, not interlocked, rather easily separable on decalcification.	Truncate, 40–85μ in diameter, often fused, in contact above with those adjacent for $\frac{1}{5}$–$\frac{2}{3}$ their length, interlocked, separable with much difficulty on decalcification.

O. Beccari, of Florence, in response to our request to see this type, has sent us a fragment of a plant collected by himself at Singapore, with the explanation that it is a portion of the specimen examined by Mrs. Gepp. This Singapore plant, which had been labeled *Halimeda papyracea* Zan., is evidently a form of *H. Tuna*, as already determined by Mrs. Gepp.

Utricles of subcortical layer.	Subturbinate, obconical, cornucopiaeform, or clavate, 35–110 μ in maximum width, often scarcely larger than the peripheral utricles.	Bullate, varying from broadly funnelform to subglobose, mostly ventricose-obovoid, 110–215 μ in maximum width, always much larger than the peripheral utricles.
Nodal filaments of the central strand.	Fusing in twos or threes, often somewhat coherent just above the points of fusion.	Fusing in twos, rarely in threes, not coherent, the fusion often incomplete.

In addition to the differences mentioned above, the utricles of the subcortical layer form a more compact flat-topped stratum in *H. discoidea* than in *H. Tuna*, as will be seen by comparing FIGURE 11 with FIGURE 1. It should be mentioned that in drying the large utricles of the subcortex of *H. discoidea* commonly collapse and are flattened against the medulla and often revive imperfectly on being soaked out; this is especially true of specimens which have been long in herbaria and it doubtless explains why this striking peculiarity has not received earlier recognition.

In the firm and extensive contact of the peripheral utricles, *Halimeda discoidea* bears some resemblance to *Halimeda cuneata* Hering, originally described from Natal Bay, but otherwise the two have little in common. We have not seen Hering's original specimen, but have examined a plant from Natal agreeing in every respect with his description. In this, the peripheral utricles measure 27–44 μ in diameter, surface view, and show no evidence of fusion; they are 60–110 μ long, are in close contact distally for $\frac{1}{4}$–$\frac{3}{5}$ their length, are obconical or clavate, surmounted in a somewhat capitate fashion by the coherent distal parts, which appear subquadrate in a radio-vertical section. The utricles of the subcortical layer are only 27–55 μ in maximum diameter, scarcely larger than those of the peripheral stratum, are 2–4 times dichotomous (*i. e.*, in 2–4 series), and obconical, ovoid-turbinate, or clavate. The nodal filaments of the central strand fuse in twos and threes and are strongly coherent just above the points of fusion, as well described by Mrs. Gepp (*l. c.* 15–17). Branches given off from the filaments near the points of fusion form a compact narrow annular cushion above which the filaments are naked and subtorulose. This annular nodal cushion we have observed in no other species. The segments of *H. cuneata* are cuneate-obdeltoid and are almost without

exception longer than broad. The very different utricles of the subcortical layer, with other characters, well distinguish *H. cuneata* from *H. discoidea* and we think it clearly entitled to specific rank. In any event, if one's conception of specific limitations should prove sufficiently elastic to include the two under one specific name, Decaisne's *Halimeda discoidea* has the right of way on priority grounds.

The older writers on the species of *Halimeda* gave very little attention to histological characters. Kützing,* indeed, remarked upon the uniformity of their structure and considered it unnecessary to give detailed figures illustrating the anatomy of each species. Professor Askenasy† in 1888 made an important advance in describing and figuring the details of structure and in emphasizing their value in distinguishing species, but he apparently did not examine authentic material of certain species described by his predecessors, and thus quite naturally made a wrong application of some of the specific names. Mrs. Gepp (Miss Ethel Sarel Barton) in preparing her monograph of "The Genus Halimeda" (*l. c.*) recognized fully the importance of seeing original materials and rendered an important service by investigating carefully the characters of the nodal filaments of the central strand and insisting on the value of these characters in diagnosing species, but she did not emphasize sufficiently the characters of the peripheral utricles and the utricles of the subcortical layer, parts which, in most species, at least, offer peculiarities of as much constancy and value as do the nodal filaments. That the nodal filaments are not altogether invariable is seen in *Halimeda discoidea*, where fusions of the *H. Tuna* type and of the *H. Opuntia* type sometimes occur side by side in a single node (FIGURES 19 and 20) and also in *H. Monile*, in which rarely the filaments are only superficially coherent. The peripheral utricles and those of the subcortical layer also have, of course, a certain range of variation in each species; nevertheless that range is limited and these elements possess characters of taxonomic value of which any final and complete system of classification must take cognizance.

The specimens from Bermuda, Porto Rico, and Jamaica, which

*Tab. Phyc. 7: 9. 1857.

† Forschungsreise S.M.S. Gazelle 4: 11–14. *pl. 3, 4.*

we have identified with the Mediterranean *Halimeda Tuna* present some slight peculiarities which, however, we believe are not sufficiently constant and reliable to warrant a specific separation. In the first place, the American plants are more rigid and rather more calcified than the European specimens that we have seen. When growing, they are commonly suberect and cespitose, while according to Oltmanns* the flat Halimedas of the Mediterranean ("*Tuna, platydisca*") have a more or less horizontal or pendulous position. The diameter of the peripheral cells averages about 6–12 μ less than in the European specimens examined, though no smaller than in certain Adriatic representatives of *H. Tuna*. The filaments of the central strand, as shown in our FIGURES 5 and 6, are often inclined to cohere strongly at the node just above the points of fusion, while those of *H. Tuna* are usually easily separable under treatment, as described by Mrs. Gepp†; however, we have seen a specimen from the Adriatic (leg. Titius) in which the tendency of these filaments to cohere at the nodes is as pronounced as in the plants of Bermuda and Porto Rico, and Mrs. Gepp mentions (*l. c.*) a similar condition in a specimen brought from Rangiroa by Professor Agassiz. The sporangiophores in the American specimens appear to be rather more simple than those of the European *H. Tuna*, as we have noted above.

The American species of the *Halimeda Tuna* group, thus far recognized, may be distinguished by the use of the following key‡:

Peripheral utricles truncate or rounded-obtuse.

Peripheral utricles in contact for $\frac{1}{5}$ their length or less; utricles of the subcortical layer subturbinate, obconical, or clavate, 35–110 μ in maximum diameter. *H. Tuna.*

Peripheral utricles in contact for $\frac{1}{5}$–$\frac{2}{3}$ their length; utricles of the subcortical layer bullate, mostly ventricose-obovoid, 110–215 μ in maximum diameter. *H. discoidea.*

Peripheral utricles galeate-cuspidate. *H. scabra.*

*Morph. and Biol. Alg. 1: 295. *f. 182;* 296. 1904.

†Siboga-Expeditie. Monographe 60: 16. 1901.

‡Excluding *Halimeda gracilis* Harv., which agrees essentially with the members of the *Halimeda Tuna* alliance in the character of the nodal filaments, but differs considerably in the form of the segments. The type of *H. gracilis* was from Ceylon, but a specimen dredged by the Challenger Expedition at St. Thomas, West Indies, in 5 to 15 fathoms of water, appears to agree with it in most respects, though the peripheral utricles are larger and more coherent and the utricles of the subcortical layer are very long (mostly 300 to 700 μ).

C. ON THE AMERICAN SPECIES OF THE HALIMEDA TRIDENS GROUP

Even before writing "Phycological studies—II," * in which we described *Halimeda favulosa* as a new species and followed Mrs. Gepp (Ethel S. Barton) and also Harvey in considering *Halimeda Monile* (Ell. & Soland.) Lamour. a mere variety or form, we had seen both *Halimeda tridens* † (*H. incrassata*) and *H. Monile* growing in close proximity to each other in Bermuda, in Porto Rico, and in the Bahamas, and remaining apparently distinct. But the segments in both of these were subject to so much variation in outward form, even in different parts of a single individual, that plants from other localities would sometimes appear to occupy an intermediate position, and great as were the manifest differences between the best representatives of these two types it seemed difficult to draw any satisfactory line between them. When, however, in December, 1906, and January, 1907, we again saw, in several localities in Jamaica, *Halimeda tridens* and *H. Monile* growing either side by side or within a few feet of each other and always maintaining their distinctive characters perfectly, the conviction was forced upon us that a mistake had been made in considering

* Bull. Torrey Club 32: 563–586. *pl. 23–29.* 1905.

† One who has seen an extensive series of West Indian Halimedas, either growing or in an herbarium, can scarcely have any serious doubts, we believe, as to the intended application of Ellis & Solander's names *Corallina tridens* and *Corallina incrassata* or as to the impossibility of drawing any reliable line of specific separation between the two. This being granted, the next question involves a choice between the two names, published in one work at the same time. Mrs. Gepp, in her monograph of "The Genus Halimeda" (Siboga-Exped. LX) has adopted the specific name *incrassata*, presumably because Ellis & Solander's description of their *Corallina incrassata* was accompanied by the more numerous and more detailed figures. The Rochester and the Philadelphia codes of botanical nomenclature give preference in such cases to the name having "precedence of position," which would here call for the adoption of the specific name *tridens*, the name which, fortunately, in America, at least, has been the more generally employed. The recent Vienna Code (Art. 46) provides that "when two or more groups of the same nature are united, the name of the oldest is retained. If the names are of the same date, the author chooses, and his choice cannot be modified by subsequent authors." In the case in hand, technical priority in the matter of publishing a choice between the two names appears to lie, by a narrow margin, so far as we can discover, with Mr. F. S. Collins, whose choice of *Halimeda tridens* appeared in print in November, 1901 (Proc. Am. Acad. Arts and Sci. 37: 246) while Mrs. Gepp's monograph, in which the name *Halimeda incrassata* is preferred, bears the date of December, 1901.

them forms or varieties of one species and that in addition to their more obvious peculiarities a careful comparison under the microscope would be likely to reveal histological characters of diagnostic value. We have now been able to compare microscopically specimens representing fifty-seven collection-numbers of these two "forms" from Bermuda, southern Florida, and the West Indies, and the results are of interest. In *Halimeda tridens* the peripheral utricles show a range of from 49 to 77 μ in average maximum diameter in surface view; that is, on measuring the distal ends of each the longest way, the average in some individuals is as low as 49 μ and in others as high as 77 μ. In the representatives of *H. Monile*, the peripheral utricles, measured in the same way, range from 30 to 44 μ in diameter; and they are more strongly coherent after decalcification, their lateral walls being in contact for $\frac{1}{3}$–$\frac{1}{10}$ their length *vs.* $\frac{1}{8}$–$\frac{1}{20}$ their length in *H. tridens*. And the utricles of the subcortical layer, at least those of the outmost series, are narrower and less rounded than in *H. tridens*, being 24–55 μ in greatest width *vs.* 35–95 μ, and obconical, clavate, or obovoid, rather than turbinate, subglobose, or ellipsoidal. *Halimeda tridens* and *H. Monile* occasionally simulate each other in form, as indeed in an even greater degree do *Halimeda Tuna* and *H. scabra*, and it is not surprising that Lamouroux, Harvey, and others who have depended upon externalities have had doubts as to their specific distinctness; but we believe that they are really distinct and that they constitute species in the best sense of the word. Ninety-five per cent. of the specimens that one meets with can easily be referred at sight to the one species or the other, and in the case of the few that may seem doubtful on first inspection, an accurate measurement of the peripheral utricles has, thus far, afforded a satisfactory basis for determination.

In addition to *Halimeda tridens*, *H. Monile*, and *H. favulosa*, there is a fourth member of this alliance which we have thus far met with five times in Porto Rico, Jamaica, and the Bahamas, and which holds its distinctive characters so constantly in varying depths of water and under other diverse conditions that we believe it entitled to specific rank. A description of it follows:

Halimeda simulans sp. nov.

Dark- or rather light-green when living, sometimes becoming yellowish-green on drying, erect or somewhat flaccid, 6–15 cm. high, flabellate or subflabellate in habit, sessile or subsessile, the one or two lowest, more or less modified, flattened segments often forming a sort of stipe, strongly calcified, the calcification soon involving the medulla and reaching the outer surface of the peripheral utricles, the surface dull or slightly nitent, appearing smooth, solid, and compact, even under a lens; branching in one plane, usually trichotomous: rhizoids commonly forming a bulbous mass with the adherent sand: segments discoid, plane or obscurely 1- or 3-nerved, subquadrate-reniform, subquadrate, or rhombic-ellipsoidal, rarely obovate, nearly always broader than long, mostly subentire or 3–7-crenulate, sometimes 3-dentate or 3-lobed, 2–9 mm. long, 4–12 mm. broad, 0.5–2 mm. thick (those of extreme base now and then 3 mm. thick): peripheral utricles turbinate or subcrateriform, 27–80 μ long, 33–40 μ in average maximum diameter in surface view, truncate or rounded-obtuse, lateral walls in contact for $\frac{1}{3}$ to $\frac{1}{10}$ their length, usually cohering rather firmly on decalcification: utricles of the subcortical layer in a double, triple, or rarely quadruple series, those of the outmost series turbinate, obovoid, subglobose or ellipsoidal, 30–72 μ in maximum width, those of the inmost series obovoid, obconical, or clavate, 41–110 μ in greatest width: filaments of the central strand strongly coherent at the nodes, communicating there with those adjacent by open pits or very short tubular processes and exhibiting there thickened and often colored walls: sporangia unknown. [PLATE 29.]

Growing on a sandy bottom or occasionally on stones in 3 dm. of water and down to a depth of several meters. Porto Rico: *no. 4332*, type (Culebra Island, M.A.H. — also *no. 4383*); Jamaica: *nos. 4837b* and *4845* (Montego Bay); Bahama Islands: *no. 3561* (Frozen Cay, Berry Islands).

Halimeda simulans is a member of the *Halimeda tridens* (*H. incrassata*) group, being probably most nearly allied to J. Agardh's *Halimeda incrassata α ovata* [Till Alg. Syst. **5**: 86. 1887. —"Hab. ad insul. Noukahiva (Jardin)"] the evident type of which is no. 15892 in the Agardh herbarium at Lund. But the peripheral utricles of this Noukahiva specimen average 50 μ in maximum diameter, which would throw it into the form cycle of *H. tridens* according to the measurements which thus far have proved reliable in helping to distinguish the West Indian species of this group. The Noukahiva plant is also less calcified than our

Halimeda simulans and has some of the other minor peculiarities of the true *H. tridens.*

In its nearly sessile plants and in the form of its segments, *Halimeda simulans* sometimes outwardly resembles *H. Tuna*, but its segments are much thicker and more rigid than in that species and they commonly have marginal crenulations or sometimes short lobes which are wanting in *H. Tuna;* and the behavior of the filaments of the central strand at the nodes is very different in the two species. On Culebra Island, *Halimeda simulans, H. Tuna*, and *H. tridens* were found growing within short distances of each other, and no intermediates were discovered. On the outside shore of the outmost of the Bogue Islands, Montego Bay, Jamaica, on January 7, 1907, *H. simulans* was found growing side by side with *H. Tuna*, while within a few rods were *H. tridens* and *H. Monile*, and no forms showing any intergrading among these four species, as we prefer to call them, were observed. From Frozen Cay, Berry Islands, Bahamas, the only *Halimeda* that we brought away besides the *H. simulans* was one of *H. scabra*, but *Halimeda tridens* is in general rather common throughout the Bahamian archipelago.

A key to the American representatives of the *Halimeda tridens* group may be arranged as follows:

Filaments of the central strand coherent at the nodes, communicating there with those adjacent by pits or very short tubular processes, rarely (now and then in *H. Monile*) merely thick-walled at the nodes and separable; segments flattened or subterete, often 3-lobed or 3-dentate.

Peripheral utricles less than 80 μ in average maximum diameter, surface view.

Peripheral utricles 49–77 μ in average maximum diameter, surface view; segments usually flattened. *H. tridens.*

Peripheral utricles 30–44 μ in average maximum diameter, surface view.

Segments mostly subterete. *H. Monile.*

Segments discoid (suggesting *H. Tuna*). *H. simulans.*

Peripheral utricles 175–190 μ in average maximum diameter, surface view. *H. favulosa.*

D. ON THE SPORANGIA OF AVRAINVILLEA NIGRICANS

(PLATE 28, FIGURES 8–25)

On January 5, 1907, at Montego Bay, Jamaica, while washing and preparing some specimens of *Avrainvillea nigricans* and *A. longicaulis* (*A. Mazei*) which had been collected there in shallow

water earlier in the day, our attention was arrested by one plant of *Avrainvillea nigricans*, the surface of which was rather abundantly covered with protruding capitate or subclavate filaments. Remembering that "Fortpflanzungsorgane unbekannt" * was the most that had been said of the mode of reproduction in this genus *Avrainvillea*, which had been recognized since 1842, we proceeded to examine the newly found structures with much interest. The enlarged terminal portions of these filaments varied in form from clavate and fusiform to pyriform or subglobose and they had the appearance of being stipitate, being raised above the general surface once or twice their own length by a scarcely modified part of the filament. The younger and smaller as well as some of the larger of these peculiar bodies were intensely green, contrasting notably with the dingy-fuscous tint of the plant in general, but many of the older and larger had turned brown, the color residing partly in the filament wall and partly in the contents and being evidently an intensification of the color characteristic of the ordinary vegetative condition of the species. After a microscopic examination, the plant was placed in a jar of seawater with the hope that on the following morning living zoöspores might be seen to emerge from the suspected sporangia. But our hopes were disappointed. Then, as on the previous evening, many of the supposed sporangia contained usually from three to five (one to eight) ovoid, pyriform, elongate-ellipsoidal, or difform bodies, occupying together one-half or more of the cavity of the enlargement. Impressed by the evident lack of homology with what little is known of reproduction in other members of the *Codiaceae*, we suspected that these peculiar interior bodies might be endophytic parasites of some sort and that the sporangium-like swellings might be simply galls caused by their presence, and so, with the conviction that the *Avrainvillea* was by this time dead, we added formalin to the seawater to preserve the interesting specimen for further study at some more convenient time. Subsequent investigations have succeeded in bringing to light practically all stages in the development of the sporangium-like organs, including great numbers of withered and empty ones, and nothing has been discovered to indicate that the more or less spore-like bodies

* Wille; Engler & Prantl, Nat. Pflanzenfam. 1^2: 141. 1890.

are anything other than normal parts of the *Avrainvillea* itself; they certainly contain chlorophyl and starch and the chloroplasts appear to be of the same character as those of the ordinary filaments of the thallus. Indeed, the supposed sporangia occur in too great profusion, even though on a single plant, and they are too regular in form and position, we believe, to be anything else than normal.

The sporangia are always terminal on branches, which, except for the presence of the sporangium, are but slightly different from the ordinary vegetative filaments of the flabellum, being, however, less moniliform or torulose, and often more slender than the filament from which they spring. These sporangiophores result from the ordinary forking of the filaments and they are commonly homologous with a vegetative branch which would undergo two or three more dichotomies (FIGURE 15). Some which can be traced back to the deeper-lying filaments are falsely lateral in origin. The form of the sporangia has been alluded to above, but the figures published herewith give a more accurate idea of their character. They vary from 0.35 to 0.83 mm. in length and from 0.20 to 0.35 mm. in width. Sometimes, as shown in FIGURES 22 to 24, the base of the sporangium, underneath the spores, is occupied by a brownish mass of slime or mucilage, forming a more or less complete basal septum. The plug, however, is perhaps more commonly near the base of the sporangiophore, as shown in FIGURE 15. Occasionally, as in FIGURE 13, the stoppage is near the middle of the sporangiophore. Often, two such plugs may be found, one at the base of the sporangium and the other at the base of the sporangiophore. The brown callose-mucilage evidently furnishes the material for healing the wound caused by the withering away of the empty sporangium. Numerous brown, rounded, thick-walled, stump-like processes, like that shown in FIGURE 20, may be found, indicating the position of former sporangiophores. It rarely happens that practically the whole protoplast of the sporangium is consumed in the formation of a single spore, but the usual number is three, four, or five, as stated above, though occasionally as many as six, seven, or eight are formed. The spores are most commonly long-ovoid or pyriform and as they lie in the sporangium the broader end is usually upward. They are densely crowded with chloroplasts and starch-grains but as they mature the amount of

starch appears to increase at the expense of the chlorophyl. Some of the spores show a pronounced polarity, or perhaps it may be called a beginning of germination, while still in the sporangium. Thus, in the second spore from the right in FIGURE 21, the foot or base of the young plant is plainly manifest. Such basal parts have less chlorophyl and starch than the remainder of the spore. The membrane enclosing the spore is usually thin and delicate and often scarcely demonstrable. When the spores are well formed, there is a peculiar aggregation of granules at the apex of the sporangium (FIGURES 21, 24) and this appears to be followed soon by the rupturing of the sporangium wall in this region, forming a rather wide irregular opening. All the spores in any single sporangium seem to be discharged at about the same time, for the sporangia as found, with a few possible exceptions, are either empty or contain their full complement of spores. Very little is known of the history of the spores on leaving the sporangium. FIGURE 19 shows a spore which had been caught at the mouth of the sporangium and had evidently begun its extra-sporangial growth, forming an evident foot and the first "bead" of a moniliform filament; this was firm-walled and very brown.

The large size of the spores (130–300 μ × 66–120 μ), their heavy load of starch, and their occasional development of an evident foot while still in the sporangium, make it practically certain, in our opinion, that these bodies are not self-motile, *i. e.*, that they are *aplanospores*. Yet, the thinness of the surrounding membrane and the fact that none of the bodies has thus far been found germinating on the surface of the thallus (if we except the captured one shown in FIGURE 19) have suggested the possibility of their being synzoöspores. However, it is much more probable that we have to do with aplanospores, perhaps analogous to those which occur in smaller size and larger number in *Gomontia polyrhiza* (Lagerh.) Born. & Flah. or to those which have been described as occurring singly in *Vaucheria hamata* and *V. geminata*.*

E. ON THE AMERICAN SPECIES OF AVRAINVILLEA

In a former paper† we alluded to some of the difficulties in the way of distinguishing species in the genus *Avrainvillea* and com-

* Waltz, J. Jahrb. Wiss. Bot. **5**: 132, 133. 1866.

† Bull. Torrey Club **32**: 565–568, 586. 1905.

mented on the characters of the original specimens of *Avrainvillea nigricans* Decaisne and *Rhipilia longicaulis* Kütz. Since that time we have enjoyed the opportunity of seeing again living plants of this genus in Porto Rico and in Jamaica, and have arrived at conclusions that are, to us, more satisfactory as to the number of species that are represented in the West Indian waters, in so far as one may judge of the matter from the material now at hand. We therefore venture to give below a diagnosis of the genus, a key to the American species, and a synoptical account of the four species that we recognize.

AVRAINVILLEA Decaisne, Ann. Sci. Nat. II. **18**: 108. 1842
Fradelia Chauvin, Recherches 124. 1842.
Chloroplegma Zanard. Mem. R. Ist. Ven. **7**: 290. 1858.

Thallus fusco-nigrescent, tawny-green, or olivaceous, usually flabelliform and stipitate, more rarely difform or irregularly digitate, destitute of calcareous incrustation, composed of dichotomous interwoven cylindrical, torulose, or moniliform threads, these nearly similar throughout, being without specialized corticating branches and without fibular processes. Stipe, when differentiated, simple or sometimes forked, terete or flattened. Flabellum suborbicular, reniform-cordate, or cuneiform, or (in *A. Rawsoni*) deficient, rarely zonate. Rhizoids in an irregularly bulbous mass or sometimes forming a rhizome. Sporangia (known only in *A. nigricans*) terminal on filaments exserted from surface of flabellum, containing a few (1–8) spores (aplanospores?). All species marine.

Type species, *Avrainvillea nigricans* Decaisne.

Key to the American species

Thallus eventually developing a flabellum (usually stipitate).
- Fusco-nigrescent or tawny-green; surface subvelutinous, minutely spongiose, or strigose: filaments of flabellum 28–70 μ in diameter.
  - Filaments of flabellum moniliform. 1. *A. nigricans.*
  - Filaments of flabellum cylindrical with a strong constriction at base of each branch, rarely subtorulose. 2. *A. longicaulis.*
- Olivaceous or cinereous; surface smooth and compact; filaments of surface of flabellum 6–24μ in diameter. 4. *A. levis.*

Thallus not developing a flabellum, forming more or less digitate, sometimes capitate lobes, these commonly very irregular in form, and often branching, diffluent, or anastomosing. 3. *A. Rawsoni.*

1. AVRAINVILLEA NIGRICANS Descaisne, Ann. Sci. Nat. II. 18: 1842.— M. A. Howe, Bull. Torrey Club **32**: 567, 568. 1905.
Fradelia fuliginosa Chauvin, Recherches 124. 1842.

Avrainvillea longicaulis Murr. & Boodle, *p. p.* Jour. Bot. **27**: 70. *pl. 228. f. 1–5.* 1889. (Excluding syn. *Rhipilia longicaulis* Kütz.)

Usually fusco-nigrescent when living or rarely tawny-green, of a similar color on drying or somewhat darker or more sordid, gregarious or scattered, normally with a stout horizontal rhizome (commonly left in substratum as ordinarily collected), or, when small and poorly developed, with a somewhat bulbous or difform base: stipe cylindrical or flattened, 1–16 cm. long, 3–14 mm. wide, now and then deficient or scarcely differentiated, simple or rarely forked near the base: flabellum varying from suborbicular (reniform-cordate when young) to cuneiform (sometimes subclavate when young), 1–25 cm. broad, entire or more or less lacerately or digitately lobed, thin and membranous in the broader forms, thicker and more coriaceous in the narrower, felt-like in texture, very obscurely or not at all zonate, the surface subvelutinous or minutely spongiose: filaments of flabellum distinctly moniliform or torulose (at least those near the surface) usually firm-walled and rather straight and rigid, 33–70 μ in maximum diameter, filaments of stipe similar, but with more differentiation between those of surface and those of interior: sporangia mostly subpyriform, varying from clavate to subglobose, 0.35–0.83 mm. × 0.20–0.35 mm., usually exserted once or twice their own length; spores ovoid, pyriform, or elongate-ellipsoidal, 130–300 μ × 66–120 μ.

TYPE LOCALITY: Iles des Saintes, near Guadeloupe, West Indies; type specimen in the herbarium of the Muséum d'Histoire Naturelle in Paris.

DISTRIBUTION: Bermuda, southern Florida, the West Indies, and South America.

Avrainvillea nigricans, as here conceived, is widely variable in form and size, though tolerably uniform in the character of its filaments. Further remarks by the writer on its range of variation may be found in the place cited above.

2. AVRAINVILLEA LONGICAULIS (Kütz.) Murr. & Boodle, *p.p.* Jour. Bot. **27**: 70. 1889. (Excluding all but syn. *Rhipilia longicaulis* Kütz., which may be fairly considered the "type" of the new binomial.)

Rhipilia longicaulis Kütz.* Tab. Phyc. **8**: 13. *pl. 28. f. II.* 1858.

Avrainvillea Mazei Murr. & Boodle, *l. c. pl. 288. f. 6.*

* M. A. Howe, Bull. Torrey Club **32**: 586. 1905.

Fusco-nigrescent or sometimes sordid- or tawny-green when living, of a similar color on drying, gregarious or scattered, with or without a horizontal rhizome: stipe flattened or subterete, 1–15 cm. long, 3–10 mm. wide, rarely deficient, simple or forking near the base: flabellum cuneate-obovate, oblong, or sometimes suborbicular, now and then diffuse, imperfectly complanate, and irregularly lobed, 1–12 cm. broad, coriaceous in the smaller forms, thinner and of looser texture in the larger, most obscurely or not at all zonate, the surface strigose, subvelutinous, or minutely spongiose: filaments of flabellum cylindrical, strongly constricted just above the dichotomy, rarely here and there subtorulose, usually firm-walled and mostly rather straight and rigid, 28–70 μ in diameter; filaments of surface of stipe commonly more slender, interwoven, rhizoid-like, those of interior sometimes crowded with amylum grains.

TYPE LOCALITY: "Ad Antillas" [Antigua]; type specimen in the Sonder collection of the National Herbarium of Victoria, Australia.

DISTRIBUTION: Bermuda and the West Indies.

The maintenance of the binomial *Avrainvillea longicaulis* for the present species and the crediting of the name to Murray & Boodle are both, we believe, technically correct, even though it may prove a source of some confusion for a time, inasmuch as Murray & Boodle evidently intended that another species — the true *A. nigricans* Decaisne — should bear Kützing's name *longicaulis*. But, as Murray & Boodle in proposing the new combination *Avrainvillea longicaulis* cited Kützing's *Rhipilia longicaulis*, it cannot be denied that this new combination applies also to Kützing's species and that it applies to it in a peculiar and typical way. Notes by the present writer on Kützing's type-specimen have been published in the place cited above and in the same paper also (pages 567, 568) are comments on the relationship of the present species to *A. nigricans*. *A. longicaulis* and *A. nigricans* often grow intermingled and resembling each other so closely that they cannot be determined without a microscopical examination, yet the more that we see of them the more we are inclined to the belief that they represent true species.

3. **Avrainvillea Rawsoni** (Dickie)

Rhipilia Rawsoni Dickie, Jour. Linn. Soc. **14**: 151. *pl. 11. f. 1, 2.* 1874.

Avrainvillea nigricans Murr. & Boodle, *p.p.* Jour. Bot. **27** : 70. 1889. Not *A. nigricans* Decaisne.

Mostly bright- or sordid-green when living, becoming fuscous-brown or nigrescent on drying, forming cespitose masses with usually crowded, subterete, fusiform, clavate, or finger-shaped, sometimes capitate, often difform, branched, and anastomosing lobes, never developing a flabellum ; lobes azonate, mostly 4–12 cm. long and 0.5–4.0 cm. in diameter, now and then disappearing in irregular cushions by fusing, the surface velutinous, spongiose, or substrigose : filaments of the lobes subtorulose or the inner cylindrical with occasional constrictions, always strongly constricted just above the dichotomy, rather thin-walled and somewhat easily collapsible, 28–68 μ in diameter. [PLATE 30.]

TYPE LOCALITY: Barbados ; type in the herbarium of the British Museum.

DISTRIBUTION: The West Indies.

Apparently common in the West Indies, ranging at least from the northern Bahamas to Jamaica and Porto Rico, growing from low-water mark down to a depth of one meter, often on exposed rocks near the low-water line. The species is represented in the herbarium of the New York Botanical Garden at the present time by specimens under seventeen collection numbers. *No. 770* of the Phycotheca Boreali-Americana of Collins, Holden, and Setchell, issued as *Avrainvillea longicaulis* (Kütz.) Murr. & Bood., and *no. 771* of the same series, issued as *Avrainvillea nigricans* Decaisne, both collected at Montego Bay, Jamaica, by Mrs. C. E. Pease and Miss E. Butler, belong with the present species, at least in the three sets examined, though in one set, the material issued under no. 770 is mixed with *A. nigricans ;* however, all three of the species named are found at Montego Bay. *Avrainvillea Rawsoni* is the plant that we once* referred to as "what we believe to be a low-littoral or shallow-water condition of *Avrainvillea Mazei*," but since we have seen it growing profusely in deeper water in Jamaica closely associated with both *A. longicaulis* (*A. Mazei*) and *A. nigricans* and without showing the least tendency to intergrade with either, we cannot do otherwise than consider it abundantly entitled to specific rank. The plant evidently never develops a true flabellum and the filaments are thinner-walled, more collapsi-

* Bull. Torrey Club **32** : 568. 1905.

ble and more torulose than is ordinarily the case in the true *A. longicaulis* (*A. Mazei*) and they are thinner-walled and less moniliform than in *A. nigricans*. The specimen selected for our photograph (PL. 30) represents a common form of the species, though its lobes are narrower, more clavate or subfusiform than those of the plant originally described and figured by Dickie.

4. AVRAINVILLEA LEVIS M. A. Howe, Bull. Torrey Club **32**: 565. *pl. 23. f. 1; pl. 26. f. 8–10.* 1905

Avrainvillea sordida Murr. & Boodle, Jour. Bot. **27**: 70. 1889. Not *Avrainvillea sordida* (Mont.) Crouan;* Mazé & Schramm, Essai Alg. Guad. 89. 1870–'77.

TYPE LOCALITY: Cave Cays, Exuma Chain, Bahamas.

DISTRIBUTION: Bahamas; Jamaica; Guadeloupe; Grenada (*fide* Murray & Boodle).

SPECIES EXCLUDENDAE

After examining authentic specimens, we agree with Murray & Boodle † in referring *Rhipilia tomentosa* Kütz. to *Udotea* and in identifying with it *Avrainvillea laetevirens* Crouan. However, the characters of this species seem to make the line of separation between the genera *Avrainvillea* and *Udotea* an almost arbitrary one. Outside of the possession of occasional attachment organs by the filaments — so little abundant that they were overlooked by Kützing — the species has more in common with *Avrainvillea* than with *Udotea*, bearing, in fact, a close external resemblance to certain conditions of *A. longicaulis*. Our *no. 3209*, from North Cat Cay, Bahamas, evidently belongs with *Udotea tomentosa*. ‡

* For a discussion of the technical application of this name, see Bull. Torrey Club **32**: 566. 1905.

† Jour. Bot. **27**: 72. 1889.

‡ UDOTEA TOMENTOSA (Kütz.) Murray, Jour. Bot. **27**: 239. 1889.

Rhipilia tomentosa Kütz. Tab. Phyc. **8**: 12. *pl. 28. f. 1.* 1858.

Avrainvillea laetevirens Crouan; Mazé & Schramm, Essai Alg. Guad. 89. 1870–77 (nomen seminudum).

Plants 3–6 cm. high, from a scarcely rhizomatous base, bright-green, fading to yellowish-albescent or isabelline, without calcareous incrustation; stipe subterete or flattened, 0.5–2 cm. long, 2–4 mm. wide, simple: flabellum cuneiform-obovate, obdeltoid, or oblong-cuneiform, 3–5 cm. long, 1–3.5 cm. broad, entire, 2–4-lobed, or at length irregularly lacerate, very obscurely or not at all zonate, rather thick, uncorticated, spongiose in texture, surface spongiose tomentose, the stipe of similar appearance: filaments of flabellum thin-walled, imperfectly reviving on being soaked out, intricately

intertangled, 35–70 μ in diameter, cylindrical or irregularly inflated here and there especially at apices, usually a little constricted just above a dichotomy, the dichotomies often near together and the branches sometimes pseudolateral, many of the shorter branches (often apparently and perhaps truly lateral) terminating in 2–4 or more short small divaricate processes which serve as organs of attachment to adjacent filaments, thus forming more or less of a network; filaments of stipe similar but with greater diversity in size, those of interior 55–100 μ in diameter, those of surface often only 16–30 μ.

TYPE LOCALITY: Antigua, British West Indies; type specimen in the Sonder collection of the National Herbarium of Victoria, Australia.

DISTRIBUTION: Antigua; Guadeloupe; Bahamas.

We owe to Mr. J. R. Tovey, of the National Herbarium of Victoria, Australia, the privilege of examining a portion of the type material, including, evidently, the plants from which Kützing drew his figure *a'*.

A second West Indian species of somewhat doubtful generic position is the following:

UDOTEA LUTEOFUSCA (Crouan) Murray, Jour. Bot. **27**: 239. 1889 (nomen seminudum).

Flabellaria luteofusca Crouan; Mazé & Schramm, Essai Alg. Guad. 88. 1870–'77 (nomen seminudum).

Plants 4–10 cm. high, fuscous or dark yellowish-brown, uncalcified; stipe simple or 1–3 times dichotomous, flattened or subterete, 2–7 cm. long, 2–5 mm. wide, corticated: flabellum cuneate-obovate or irregularly semiorbicular with cuneate base, sometimes 4 or 5 flabella to a plant through forking of stipe, each 2–5 cm. long, 1–6 cm. wide, not at all or very obsoletely zonate, corticated, the surface smooth or longitudinally somewhat rugulose, the margins erose, lacerate, or irregularly lobed: filaments of the medulla yellowish or yellowish-brown, in several layers or towards the margins almost unistratose, being there commonly visible through the cortex and giving the plant a venulose appearance under a lens, 50–80 μ in diameter, cylindrical or slightly and irregularly constricted, their falsely lateral branches forming the intricate, labyrinthine cortex by repeated divaricate often somewhat zig-zag dichotomies, the ultimate branchlets of the corticating filaments 4–10 μ in diameter, decolorate.

TYPE LOCALITY: Lake Simpson, St. Martin, West Indies; type specimen *no. 1403* of the Mazé & Schramm collection in herb. Crouan (in herb. Bornet, Paris).

DISTRIBUTION: Known only from the type locality.

This interesting plant offers points of contact with the genera *Avrainvillea*, *Udotea*, and *Cladocephalus* (Bull. Torrey Club **32**: 569), but is perhaps most at home in *Udotea*, where Murray (*l. c.*) has doubtfully placed it. But we find no grounds for supposing with Murray that this "form" is an "imperfect state." In color and general habit it has most in common with *Avrainvillea*, but it is corticated; the general character of the cortex, however, is rather different from that of any other described species of *Udotea*, the corticating filaments being much more regularly dichotomous than in *Udotea Desfontainei* and without the ultimate lateral nodular excrescences or irregularly cristate-pectinate coherent branchlets of that species. In the nature of the cortex it closely resembles *Cladocephalus scoparius;* in fact, the species stands in much the same relation to *Cladocephalus* that *Udotea conglutinata* does to *Penicillus*, *Udotea conglutinata* being a *Penicillus* except in having a flabellum instead of a capitulum.

Explanation of plates 25-30

PLATE 25

1–10. *Halimeda Tuna*

1. Portion of a segment (decalcified), in radio-vertical section, showing peripheral utricles, utricles of the subcortical layer, and medullary filaments.

2 and 3. Peripheral utricles and utricles of the subcortical layer, decalcified and teased out; the peripheral utricles separating rather easily.

4. Peripheral utricles, decalcified, in surface view; no fusion is noticeable.

5. Vertical section by microtome through the filament of the central strand (decalcified) at a node; just above the points of fusion the filaments are somewhat enlarged and are inclined to cohere.

6. Two filaments from the central strand of a node, teased out, each formed by the fusion of two; just above the points of fusion there has been considerable coherence of the adjacent filaments and the outer layers of the filament-walls are more or less scarred and lacerated by the process of teasing the filaments apart.

7. A young simple sporangiophore.

8 A sporangiophore from the margin of a segment, formed by the fusion of three filaments of the central strand.

9. A forked sporangiophore from the margin of a segment, formed by the fusion of two filaments of the central strand.

10. The beginning of a sporangiophore at margin of segment. (For sporangiophores of a different origin, see Plate 28, Figures 1 and 2.)

Figures 1–10 are all drawn from formalin-preserved material of our *no. 4201* (Culebra Island, Porto Rico); 1–6 are magnified 40 diameters; 7–10, 24 diameters.

11–20. *Halimeda discoidea*

11. Portion of a segment (decalcified), in radio-vertical section, showing peripheral utricles of the subcortical layer, and medullary filaments.

12 and 13. Peripheral utricles and distal ends of the utricles of the subcortical layer, decalcified, showing contact of the peripheral utricles and their occasional interlocking.

14 and 15. Peripheral utricles, etc., showing fusion as well as interlocking.

16. Utricle of the subcortical layer bearing numerous peripheral utricles.

17. Peripheral utricles, decalcified, in surface view, showing fusions; fusions of two utricles are common; near the upper left-hand corner and a little below the middle, in the figure, are fusions of three utricles; near the lower left-hand corner is a fusion of four.

18. Peripheral utricles, decalcified, in surface view, the dotted lines indicating the form and position of the distal ends of the utricles of the subcortical layer, which are often clearly visible through the peripheral utricles.

19. Filaments from central strand of nodes, showing incomplete fusion.

20. Filament from central strand of node, showing complete fusion of two filaments to form one, which afterwards divides into three. The filaments shown in Figures 19 and 20 are from the same node.

Figures 11–20 are all drawn from formalin-preserved material of our *no. 2964* (Caesar's Creek, Florida); 11, 16–20 are magnified 40 diameters; 12–15, 55 diameters.

PLATE 26. *Halimeda discoidea*

Photograph of a formalin-preserved specimen from Caesar's Creek, Florida (*no. 2964*, 31 Mr 1904), natural size.

PLATE 27

1. *Halimeda tridens*. Photograph of a formalin-preserved fertile specimen from Tallaboa, Porto Rico (*no. 4424*, 22 Mr 1906), natural size.

2–4. *Halimeda Tuna*. Photograph of formalin-preserved fertile specimens from Culebra Island, Porto Rico (*no. 4201*, 3 Mr 1906), natural size.

PLATE 28

1 and 2. *Halimeda Tuna*

1 and 2. Sporangiophores of apparently lateral origin from the central filaments and formed without fusion; these were from the flattened face of a segment.

The figures are drawn from formalin-preserved material of our *no. 4201* (Culebra Island, Porto Rico); the magnification is 24 diameters.

3–7. *Halimeda tridens*

3. A cluster of three sporangiophores from the margin of a segment; each is a continuation of a filament of the central strand coherent with the adjacent filaments near the point of emergence and anastomosing with them.

4. A sporangiophore from the flattened face of a segment; this is a direct continuation of a utricle (distal series) of the subcortical layer.

5. Base of sporangiophore of origin similar to that shown in Figure 4.

6 and 7. Bases of sporangiophores from the flattened faces of segments; these are direct continuations of the peripheral utricles; in Figure 6 the sporangiophore forks at the base, perhaps abortively.

Figures 3–7 are drawn from formalin-preserved material of our *no. 4424* (Tallaboa, Porto Rico); all are magnified 24 diameters.

8–26. *Avrainvillea nigricans*

8. Portion of surface of the flabellum, with exserted sporangia.

9–13. Young sporangia in various stages of development. Near the middle of the stipe in Figure 13 is indicated the position of the mucous or callose plug.

14. A sporangium which has aborted and resumed vegetative growth.

15. A nearly mature sporangium; the figure shows the mucous plug near the base of the stipe and the usual relation of the sporangiophore to the vegetative filaments.

16. A young sporangium paired with an old and empty one.

17. A sporangium with spores nearly formed.

18. A pair of empty and shriveled sporangia, showing the wide erose or lacerate opening at the apex of each and the mucous or callose thickening at the base of the sporangiophore.

19. A spore adhering to the mouth of an empty sporangium, where it has begun its extra-sporangial development.

20. A healed-over "stump" left by the decay of an old sporangiophore.

21. A mature sporangium with four spores. A collection of granules at the apex seems to indicate the area of the future rupture of the sporangium-wall.

22. A mature sporangium with four spores; the base of the sporangium is nearly filled and closed by brown mucus.

23. A sporangium open at apex, although the enclosed spores are still imperfectly outlined.

24. A mature sporangium with three spores; a mucous plug in the base of the sporangium and a collection of granules at its apex.

25. A large sporangium containing four spores clearly outlined and three or more others imperfectly formed.

Figures 8–25 are all drawn from formalin-preserved material of our *no. 4794* (Montego Bay, Jamaica); 8 is magnified 12 diameters; 9–19, 24 diameters; 20–25, 52 diameters.

PLATE 29. *Halimeda simulans*

Photograph of a dried specimen (*no. 4332*, type — Culebra Island, Porto Rico, 6 Mr 1906, M.A.H.), natural size.

PLATE 30. *Avrainvillea Rawsoni*

Photograph of formalin-preserved specimen in water (*no. 4843*, Montego Bay, Jamaica), natural size.

The genus Androsace in New Mexico

Elmer Ottis Wooton and Paul Standley

The early reports upon the botany of the southwest recognize two species of *Androsace*, *A. occidentalis* Pursh and *A. septentrionalis* L. The latter species, according to Dr. E. L. Greene, does not occur in this country, being an alpine plant of the northern parts of Europe and Asia.

Of the species that formerly went as *A. septentrionalis* one has been named *A. pinetorum* by Dr. Greene in Pittonia **4**: 149, which is no doubt perfectly distinct. This species, originally described from southern Colorado, is found in the higher mountain ranges of that state and of New Mexico. The only specimens from this Territory in our herbarium are one from Bear Cañon, Sandia Mountains, collected in June, 1898, by Dr. C. L. Herrick (*no. 205*), and one collected on South Percha Creek, in the Black Range, Sierra County, May 3, 1905, by O. B. Metcalfe (*no. 1586*). It no doubt occurs in the mountains of the northern part of the Territory, since it seems to be quite common in southern Colorado. The species may be readily separated from the other members of its group by its relatively large pinkish or white flowers, whose corollas are longer than their calyces.

Another more common species of this Territory which also passed as *A. septentrionalis* is *A. diffusa* Small.* This is represented in our herbarium by specimens from the following localities in New Mexico:

In the White Mountains, Lincoln County: at Gilmore's Ranch on Eagle Creek, July 14, 1897, and August 5, 1897 (*Wooton 598*), alt. approx. 2200 meters; on Little Creek, May 11, 1899 (*Turner 168*), alt. approx. 2400 meters; White Mountain Peak, August 1, 1901 (*Wooton*), alt. approx. 3100 meters. In the Sacramento Mountains, in Otero County: at Winter Folly, August 1, 1899 (*Wooton*), alt. approx. 2700 meters; in James Cañon near Cloudcroft, August 11, 1899 (*Wooton*), alt. approx. 2400 meters. In the Sandia Mountains in Bernalillo County: in Bear Cañon, May,

* Bull. Torrey Club **25**: 318.

1898 (*C. L. Herrick 256*). In the Mogollon Mountains, in western Socorro County: on the west fork of the Gila River, near its head, August 2, 1903 (*Metcalfe 341*).

These localities show that the species is pretty well distributed over the southern two thirds of New Mexico. It is no doubt found in the northern part of the Territory, for it is also common in Colorado. It is a species of the higher mountain ranges, growing at elevations of from 2100 to 3100 meters. One of the new species here proposed, *A. glandulosa*, is evidently closely related to *A. pinetorum* and *A. septentrionalis*. It has the strict, erect scapes which are relatively long and the pedicels are but little if at all spreading. The flowers are much smaller than those of *A. pinetorum*, and the corolla, though slightly surpassing the calyx, is a clear white. The character which readily distingushes the species is the glandular pubescence found in greater or less abundance upon the leaves, scapes, pedicels, and calyces.

A. puberulenta Rydb. * is said by Dr. Rydberg to extend into New Mexico, though particular New Mexican specimens are not cited. The plant is related to *A. diffusa*, from which it may be separated by the very puberulent pedicels and calyces and the long, lanceolate, strongly keeled calyx-lobes which much exceed the fruit. Our collection does not contain specimens of the species, but it will probably be met in the higher mountains of the northern part of the Territory.

Androsace occidentalis Pursh is accredited to New Mexico by several authorities and we have some specimens from the Organ Mountains before us which we refer to that species with some hesitation, since fruiting specimens show characters not ascribed to the species and not shown by material from the central states.

Another species, *A. platysepala*, is here proposed, which is a close relative of *A. occidentalis*, though it seems to us to be sufficiently distinct to be recognized. It has the habit and broad involucral bracts of *A. occidentalis*, but the calyx-segments are noticeably different, being broadly oblong to ovate and foliaceous.

The New Mexican species of *Androsace* now known to us may

* Bull. Torrey Club 30: 260. *A. septentrionalis*, *Rothrock 51*, from Santa Fé, is probably to be referred to one of the species above mentioned. Whether *A. subulifera* (Gray) Rydb. comes into the Territory or not we are unable to say.

be separated by the following key. It is likely that further search will reveal several of the Colorado species in the mountains of the northern part of the Territory and it is altogether probable that *A. arizonica* Gray* from the Santa Catalina Mountains of southeastern Arizona will be found in the adjoining parts of New Mexico when those parts are properly explored.

Involucral bracts narrow; scapes mostly long.
- Plant glandular. — *A. glandulosa.*
- Plant not glandular.
  - Corolla longer than the calyx; scapes erect. — *A. pinetorum.*
  - Corolla equal to or shorter than the calyx; scapes divergent.
    - Calyx-lobes as long as the capsule. — *A. diffusa.*
    - Calyx lobes much longer than the capsule. — *A. puberulenta.*

Involucral bracts broad; scapes short.
- Calyx-lobes triangular, acute. — *A. occidentalis.*
- Calyx-lobes broadly oblong to ovate. — *A. platysepala.*

Androsace glandulosa sp. nov.

Annual, acaulescent: leaves basal, linear-oblanceolate or spatulate, 1–2.5 cm. long, usually 1 cm. long, 3–4 mm. wide, obtuse or acute, thin, serrate with few teeth above the middle, sparsely covered with short, scattered, glandular hairs, sessile or with winged petioles: scapes 2 or 3 to many, erect, 8–15 cm. high, covered with short glandular-viscid pubescence: bracts glandular-pubescent, lanceolate, 1–2 mm. long: pedicels slender, erect, slightly spreading with age, numerous, 2.5–8.5 cm. long, mostly 3 cm. long, with short glandular-viscid pubescence: calyx campanulate or broadly obpyramidal, strongly carinately angled even in the flowers, 2.5 mm. long, 2.5–3 mm. broad, segments narrowly triangular, very acute, hardly half as long as the pale tube: corolla white, slightly longer than the calyx, segments 1 mm. broad or less, narrowly oblong, obtuse, about half the length of the tube: anthers twice as long as the filaments: capsules globose, about the length of the calyx, 2.5–3 mm. in diameter.

Collected in New Mexico on the Middle Fork of the Rio Gila, August 5, 1900, at an altitude of about 2100 meters, by E. O. Wooton.

Androsace platysepala sp. nov.

Annual, acaulescent, 4–8 cm. high: leaves basal, blades narrowly oblong, acutish, sparingly toothed near the apex, or almost entire, sessile, 12–23 mm. long, 4–6 mm. wide; upper surface bright-green, lower surface paler; glabrous except along the

*Proc. Am. Acad. 17: 221.

margins and near the apex where they are beset with close simple pubescence: scapes numerous, simple, erect or ascending, 3.5–7 cm. long, with short, fine, abundant, branched pubescence: bracts oblong, 4–7 mm. long, 2–3 mm. wide, with short, scattered, simple pubescence on lower surfaces and margins, upper surface glabrous: pedicels slender, 7–25 mm. long, with pubescence like that of the scapes, most abundant near the summits: calyx campanulate, rather obtuse at base, 3–5 mm. high, 3–4.5 mm. wide; tube pale-green, almost glabrous, segments broadly oblong to ovate with rather acute apices tipped with reddish points, slightly overlapping one another at the base, one half longer than the tube, with abundant short simple pubescence: corolla white, shorter than the calyx, about 2.5 mm. broad, segments oblong, retuse at apex, longer than the tube: anthers twice as long as filaments.

Type *no. 1547* collected at Kingston, Sierra county, New Mexico, on open hills, March 30, 1905, by O. B. Metcalfe. This species is close to *A. occidentalis* Pursh, from which it may be distinguished by its broader, toothed leaves, and broader bracts. There is no mature fruit on the type specimens, but what is taken to be the same plant, collected on Bear Mountain near Silver City, April 24, 1903, by O. B. Metcalfe (*no. 35*, distributed as *A. diffusa* Small, from which it is altogether different) has globose capsules, 3 mm. broad by 3.5 mm. high, one third shorter than the calyx, capped by the withered remains of the corolla.

HERBARIUM OF THE
NEW MEXICO AGRICULTURAL COLLEGE.

INDEX TO AMERICAN BOTANICAL LITERATURE
(1907)

The aim of this Index is to include all current botanical literature written by Americans, published in America, or based upon American material; the word America being used in its broadest sense.

Reviews, and papers which relate exclusively to forestry, agriculture, horticulture, manufactured products of vegetable origin, or laboratory methods are not included, and no attempt is made to index the literature of bacteriology. An occasional exception is made in favor of some paper appearing in an American periodical which is devoted wholly to botany. Reprints are not mentioned unless they differ from the original in some important particular. If users of the Index will call the attention of the editor to errors or omissions their kindness will be appreciated.

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Comprises 102 species in 29 genera, 40 described as new.

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